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PRINCIPAL INVESTIGATOR IDENTIFICATION NUMBER: UN 654

PROPOSAL NUMBER: MMC # 162-06

CONTRACT NUMBER: NAS5-21875

SUBJECT: Six-Month Progress Report, "ERTS-A Imagery Interpretation Techniques in the Tennessee Valley."

The purpose of this report is to summarize the first six months of research activity on proposal MMC # 162-06 (NAS5-21875), "ERTS-A Imagery Interpretation Techniques in the Tennessee Valley," during the period from September 25, 1972 to March 25, 1973. Principal Investigator for this project is Robert E. Bodenheimer (UN 654). Since the request for GSFC Specifications S-250-P-IC had not been received prior to the submission of this report, the same format has been followed as on the previously submitted bimonthly reports.

Background. The research activity of this group (MMC # 162-06) is to provide data analysis support for ERTS investigations in several other disciplines at the University of Tennessee. Each of the other

(E73-10477) ERTS-A IMAGERY INTERPRETATION TECHNIQUES IN THE TENNESSEE VALLEY Semiannual Progress Report (Tennessee Univ.) 13 p HC $3.00 CSCL 08B

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groups (MMC # 162-02, MMC # 162-03, and MMC # 139) supported by the ERTS-1 program are generally interested in different studies and different features of the data. The projected goal for this support is to coordinate the efforts in data management and data analysis between the disciplines and to aid each individual discipline in the development and modification of analysis techniques for the maximum utilization of ERTS data.

Summarized Progress. Receipt of the first ERTS data on November 15, 1972 initiated Phase II of the study. Since this date, this group has processed eighty-five (85) data analysis requests. The following summaries indicate progress which has resulted from the first-look of ERTS data and the preliminary data analysis phase.

"Delineation of Major Soil Associations Using ERTS-1 Imagery" (MMC # 139)-UN 650

The reflectance characteristics of soils are conditioned by many factors. The soil color and soil moisture content are two factors that greatly influence soil reflectance. The medium textured soils of the southeast generally have a reddish or yellowish hue. The reflectance from these soils generally reaches a minimum at a moisture content of 16 to 18 percent by weight (about 2 bars tension). As the moisture content increases or decreases, the soil reflectance increases. Maximum soil reflectance is obtained at a moisture level near or slightly below field capacity (1/3 bar tension).

If soils are to be delineated through the use of aircraft or ERTS imagery, the best conditions are when the soil is void of vegetation and preferably in a freshly tilled state. This condition is

generally found only in areas of intensive row crop agriculture or areas where all vegetation is removed from the land each year as in sections of developing countries with extremes in yearly rainfall distribution.

Another means for soil identification is where the soil is covered with a vegetative cover characteristic to a particular soil association or soil group. This characteristic occurs in many forested areas but may also be found in other types of vegetative cover. In such cases the soil associations are delineated through the reflectance characteristics of a reasonably uniform type of vegetation possessing the same boundaries as the soil associations. The identification of vegetation types through reflectance characteristics is quite widely known and used.

The example reported herein is a case of soil association delineation through the reflective characteristics of a fairly uniform cover of vegetation. In this particular case the Memphis soil association may be identified in Obion County using ERTS imagery. This Memphis soil association occurs in the western edge of the loess that covers most of West Tennessee. The association is known as the "bluffs" and occurs at the break between the loess soils and the delta soils of the Mississippi floodplain.

The computer printout of the large block of the Memphis association is too large to be adequately shown in one photograph. Figure 1 shows a small portion of the computer printout that separates Reelfoot Lake, the Adler-Convent-Falaya, and the Memphis soil associations. Figure 2 shows the computer printout of the Obion River and the adjacent Waverly-Swamp association.

These findings demonstrate the feasibility of delineating major soils through vegetative cover characteristics common to the soils in question. Channel 7 provides the most information for studies of this type.

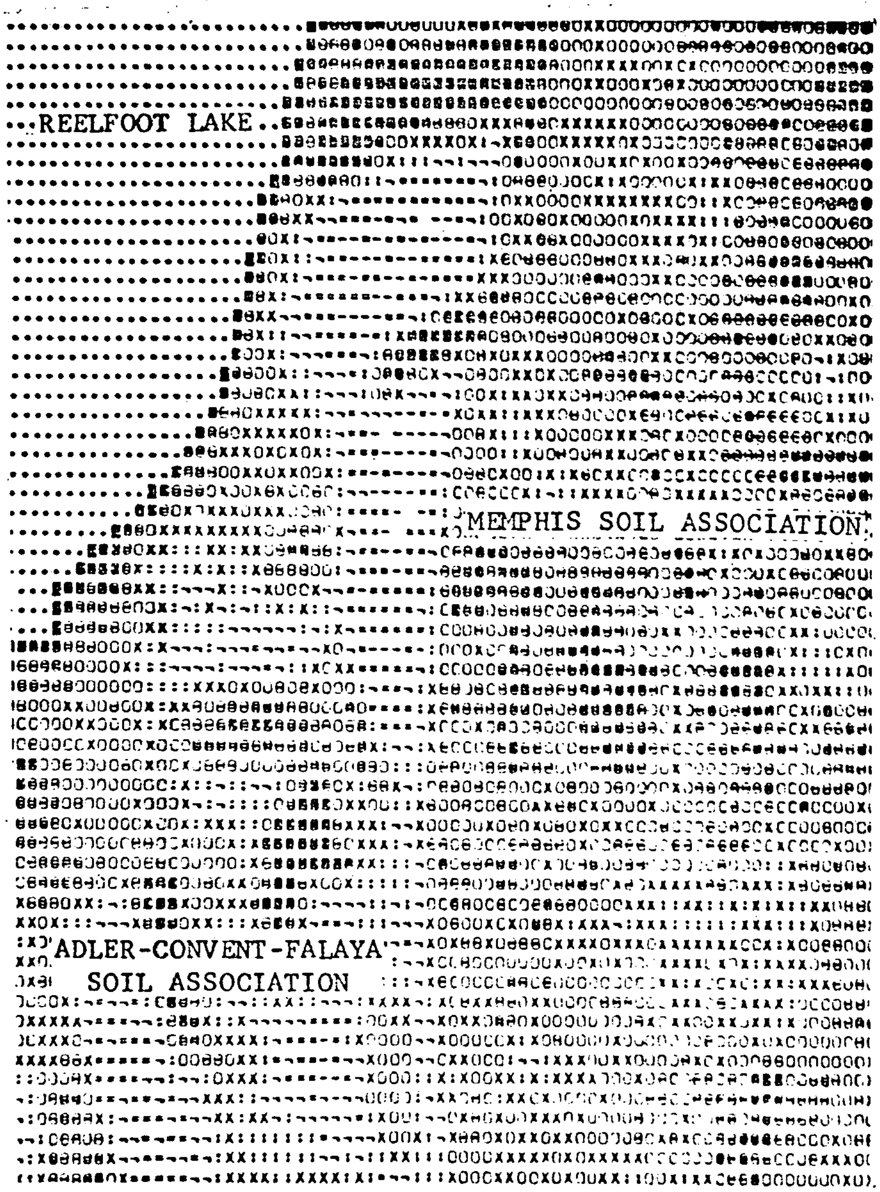

Figure 1. Computer printout from ERTS-1 imagery evaluation separating Reelfoot Lake, the Adler-Convent-Falaya, and the Memphis soil associations.

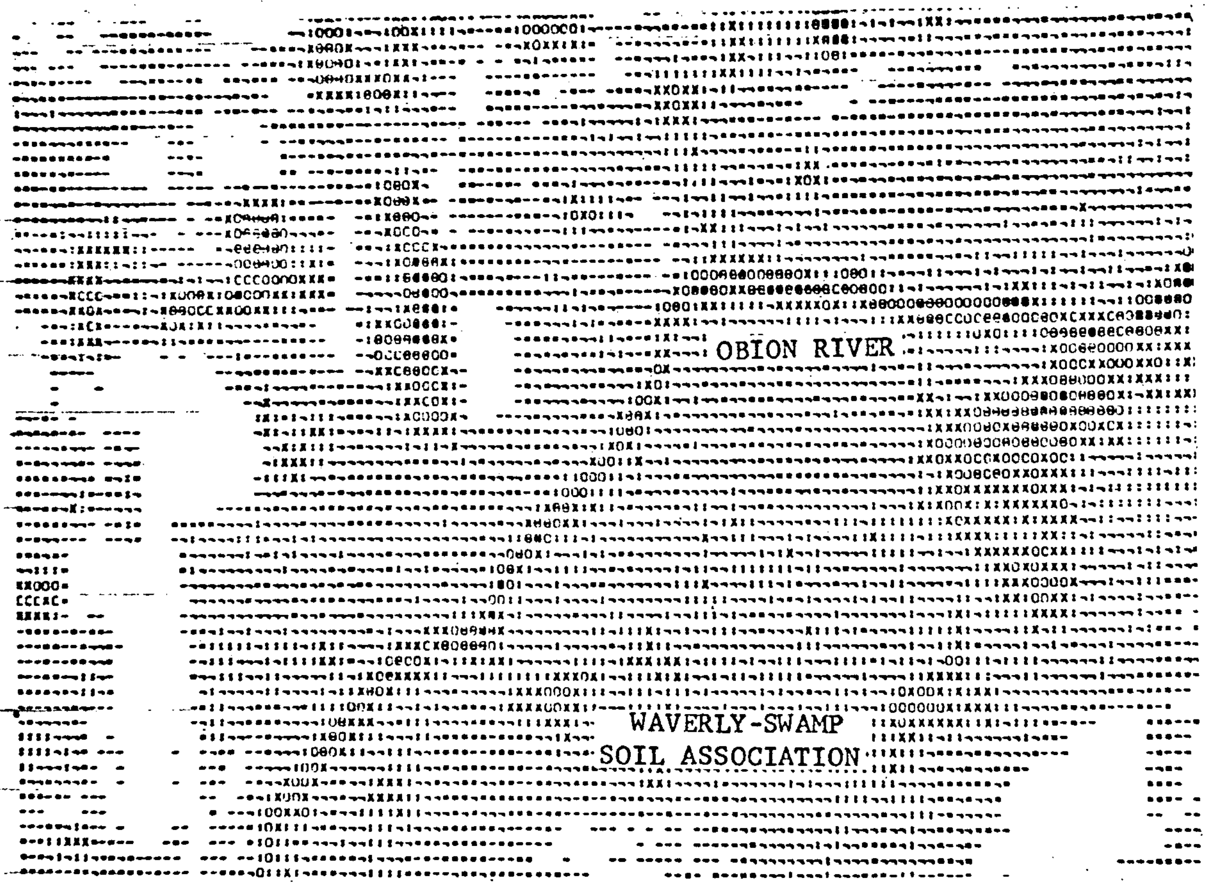

Figure 2. Computer printout from ERTS-1 imagery evaluation showing the Obion River and the adjacent Waverly-Swamp area.

"Geographic Applications of ERTS-1 Data to Landscape Change" (MMC # 162-03)-UN 212

The ERTS-1 capabilities of sensing the same geographic point every 18 days and providing a 13,225 square mile view from each image challenge us to the task of analyzing landscape change from a regional perspective. The investigation focuses on the East Tennessee Test Site, a 20,000 square mile region in which landscape change elements such as forest alterations, strip mines, highway construction, urban-suburban growth, and cyclic seasonal changes in agriculture are being analyzed. Two test sites of smaller dimensions are being intensively studies within the larger test region. The Knoxville Test Site, an 11 x 21 mile area which encompasses the city of Knoxville

and the western portion of Knox County, is being investigated for landscape change associated with urban growth. A second smaller test site on the Cumberland Plateau is being monitored for forest alterations and landform disturbances associated with surface strip mining for coal. Unfortunately, the humid East is not the most ideal region for landscape change analysis because the high percentage of cloud cover has reduced the number of useable satellite observations to three for our study area since August.

Three avenues of experimentation and analysis are being used in the investigation: (1) a multi-stage, multi-scale sampling procedure, (2) a densitometric and computer analytical experiment, and (3) an image enhancement procedure.

Microdensitometric and computer techniques are being used to analyze the ERTS imagery for gray tone signatures, comparisons, and ultimately for landscape change detection and monitoring. Using the strip mine as an example, the patterns of surface configuration are observed on a computerized map as shown in Figure 3. The experiment involves the microdensity scanning of a positive band 5 image in which strip mines appear as light tones against a dark forested background. Gray tone densities are then digitized and computer processed into a computer map and histogram (frequency distribution). By comparing such machine analyzed data from different dates of satellite observations, we can determine if the number of light tones indicating strip mined areas have increased at the expense of dark tones for the same area.

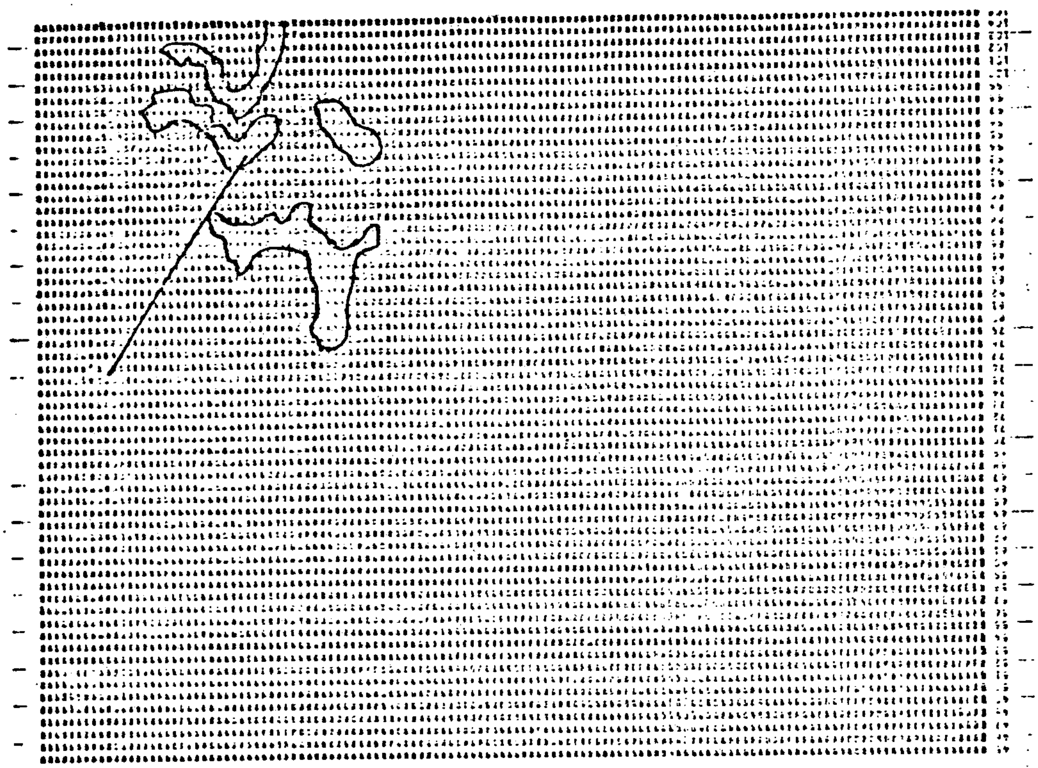

Figure 3 - Microdensity scan displayed in a computer map printout illustrating the same surface mine signatures from an ERTS band 5 image.

Barring extraneous signals from cloud cover, one then should be able to conclude that forest cover has been altered and strip mines have been increasing because of the increased frequency of light toned signatures.

Comparisons between the two histograms in Figure 4 with the upper one representing August 22 and the lower one October 15, have resulted in the inverse from the expected. This is because only two relatively clear observations for the strip mined area have been obtained and the atmospherics on August 22 created a serious cloud and haze problem. Given time and more but clearer observations, these problems can be rectified.

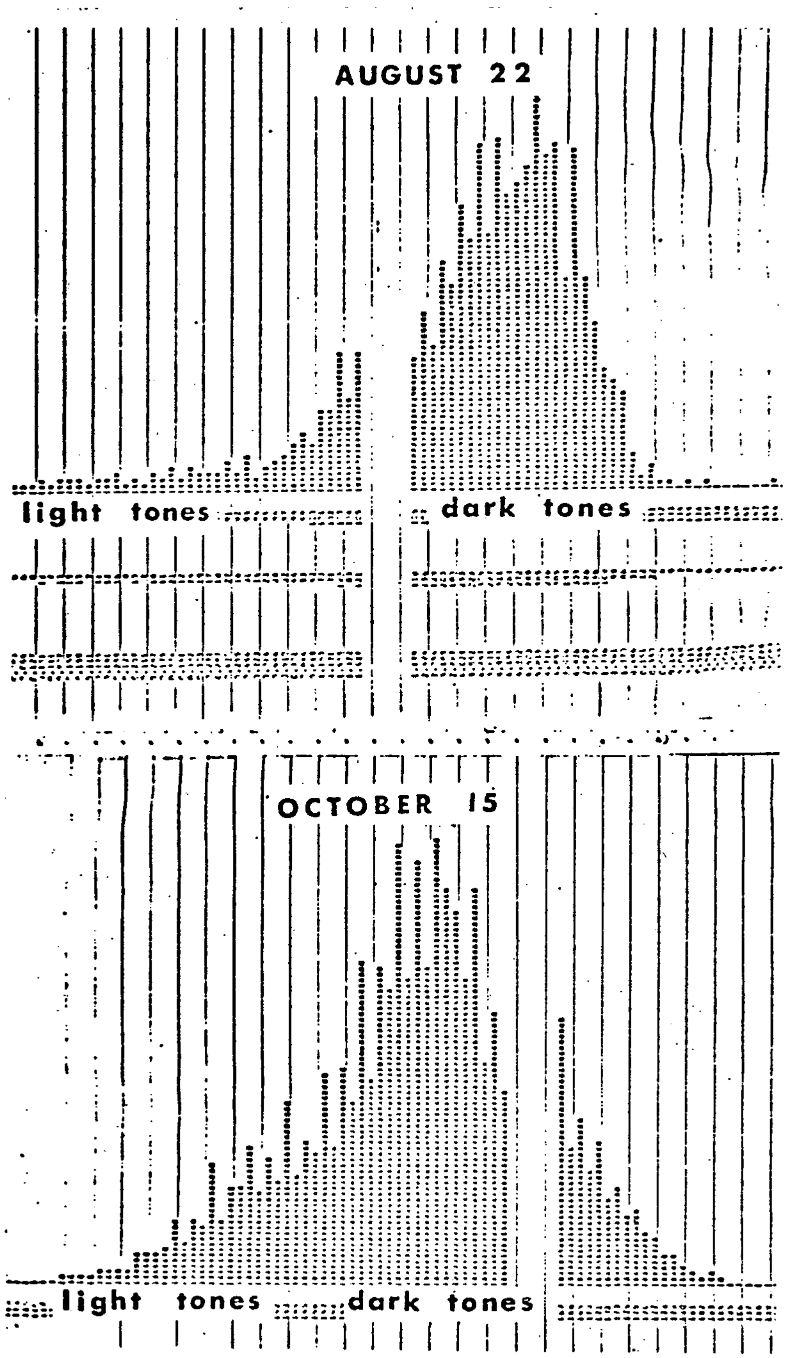

Figure 4 - Histograms of gray tone densities. ERTS band 5 images for August 22 and October 15, 1972.

Current Progress. Since the last reporting period the Data Analysis Plan (DAP) was submitted and approved. The DAP was unchanged except for the addition of an image processing and recognition laboratory.

Figure 5 indicates how this facility interfaces into the original data analysis plan. Only the block labeled "Electrical Engineering Image Processing System" is new. As is indicated in the figure, the data is received from the National Data Processing Facility (NDPF) in either magnetic tape or film form. This data is then analyzed visually by the ERTS investigators. If computer processing is required, the data can follow one of two basic paths. One way to handle the film data digitally is to digitize the film using the microdensitometer shown in Figure 1. The output of this unit is a 256-gray-level image stored on magnetic tape. This tape can then be run in the IBM System/360/65 using one of the software packages available for this type of processing. Some typical operations that are now carried out are density slicing, edge enhancement, histogram generation, and tonal digital outputs. The digitized data received from NDPF can, of course, be run directly on the IBM System/360.

A second method to process the data is to use the Electrical Engineering Image Processing System shown in Figure 1. This system is shown in more detail in Figure 6. As shown in this figure, the system consists basically of a Digital Equipment Corp. (DEC) PDP-11 computer equipped with a 9-tract industrial compatible magnetic

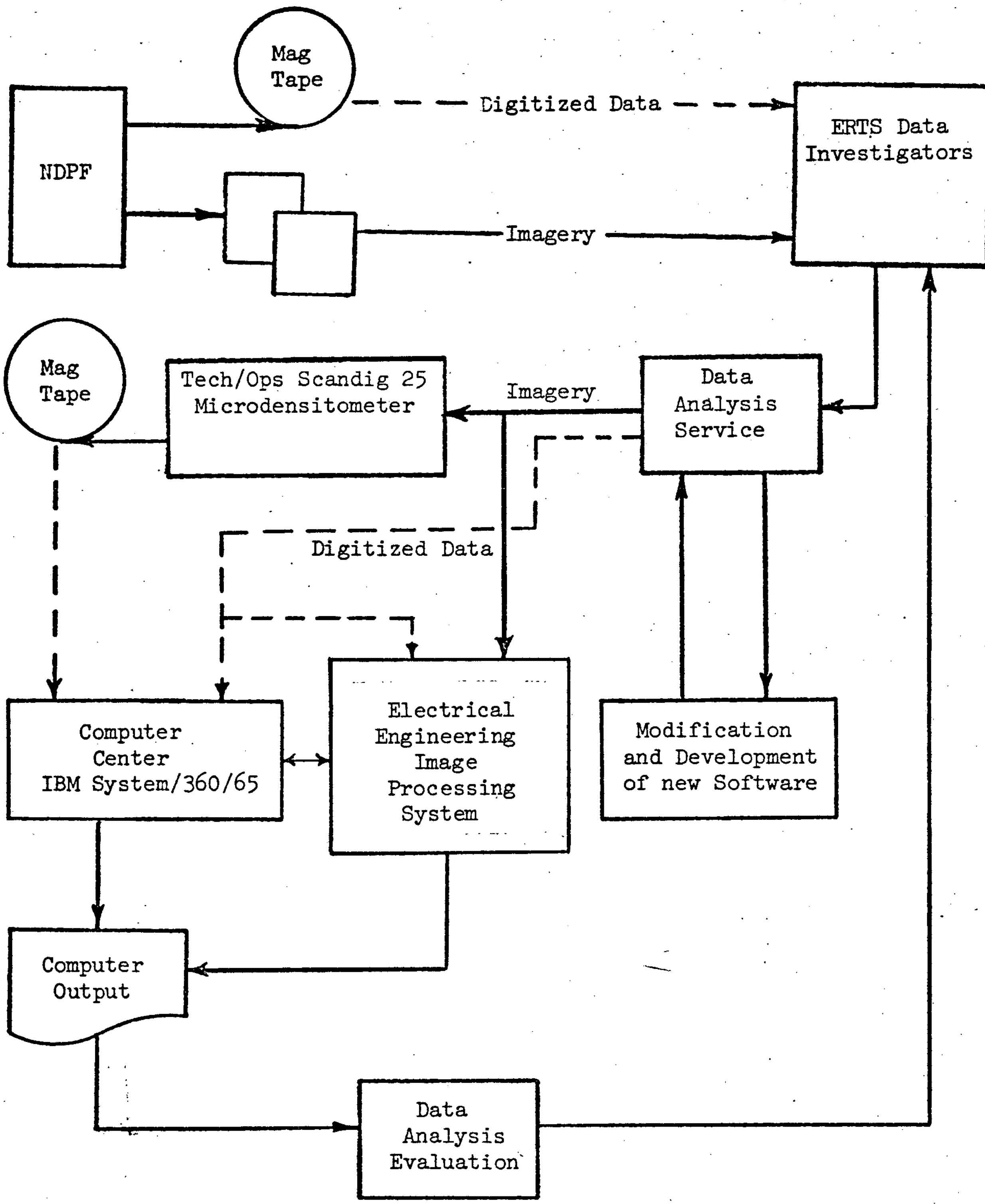

Figure 5. Flow Diagram Showing the Handling and Processing of Data

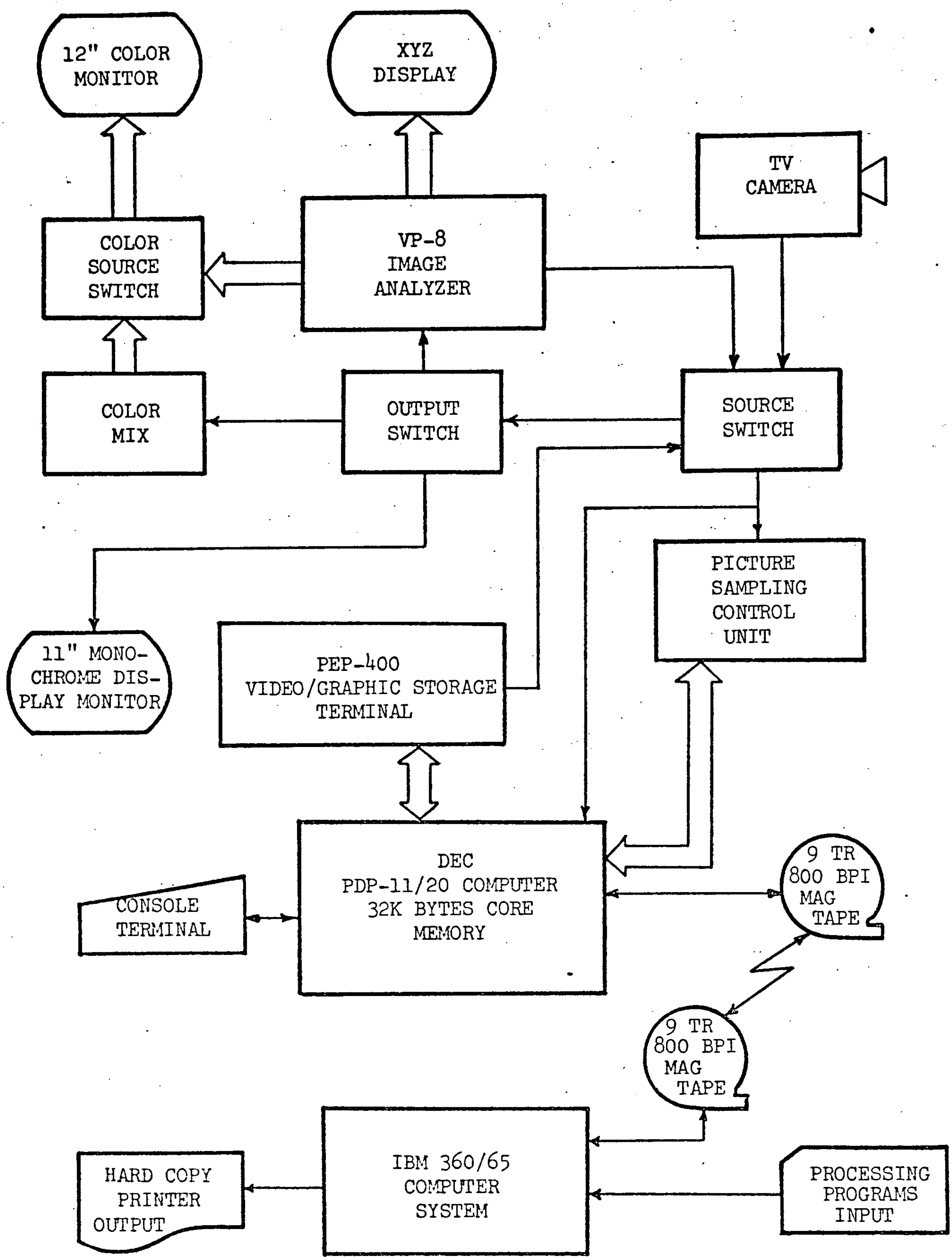

Figure 6. Block Diagram of the University of Tennessee's Computer Image Processing and Recognition Laboratory

tape unit. The computer is also equipped with a TV camera for film input, monochrome and color TV monitors, a scan converter which converts digital information into video output, and an image analyzer for general density slicing and edge enhancement. This system is capable of handling almost any processing which is presently being carried out in the IBM System/360. In addition, however, the system has the capability of displaying the processed images on either the monochrome or color TV monitor. This capability is extremely powerful since a semi-real time basis can be used. One application to this research, for example, is to scan a film image using the TV camera. The scanned image is stored on magnetic tape. This image is enhanced and displayed in pseudo color via the scan converter and TV monitor. The color combinations can be changed almost instantaneously and the image displayed again in order to accent events of interest. A computer compatible tape unit link the IBM System/360 and the image processing system. Any processing for which the PDP-11 proves inadequate can be carried out on the System/360 and the results displayed on one of the monitors. A Polaroid photograph yields a quick hard copy of the results. A summary of the pertinent specifications of those components in the image analysis system are listed below.

Except for a few minor problems, the image processing system is nearing completion. The system is now capable of reading and displaying image sizes of 128x128, 256x256, and 512x512 points. The two-dimensional fast Fourier transform algorithm is also complete and will soon be applied to ERTS data.

Next Reporting Period. Phase III of the study will be initiated. Preliminary studies from the use of the image processing laboratory will be evaluated.

Respectfully submitted,

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